HIRAD Status Report to HS3

Tim Miller, NASA/MSFC

7 May 2012

Presentation Outline

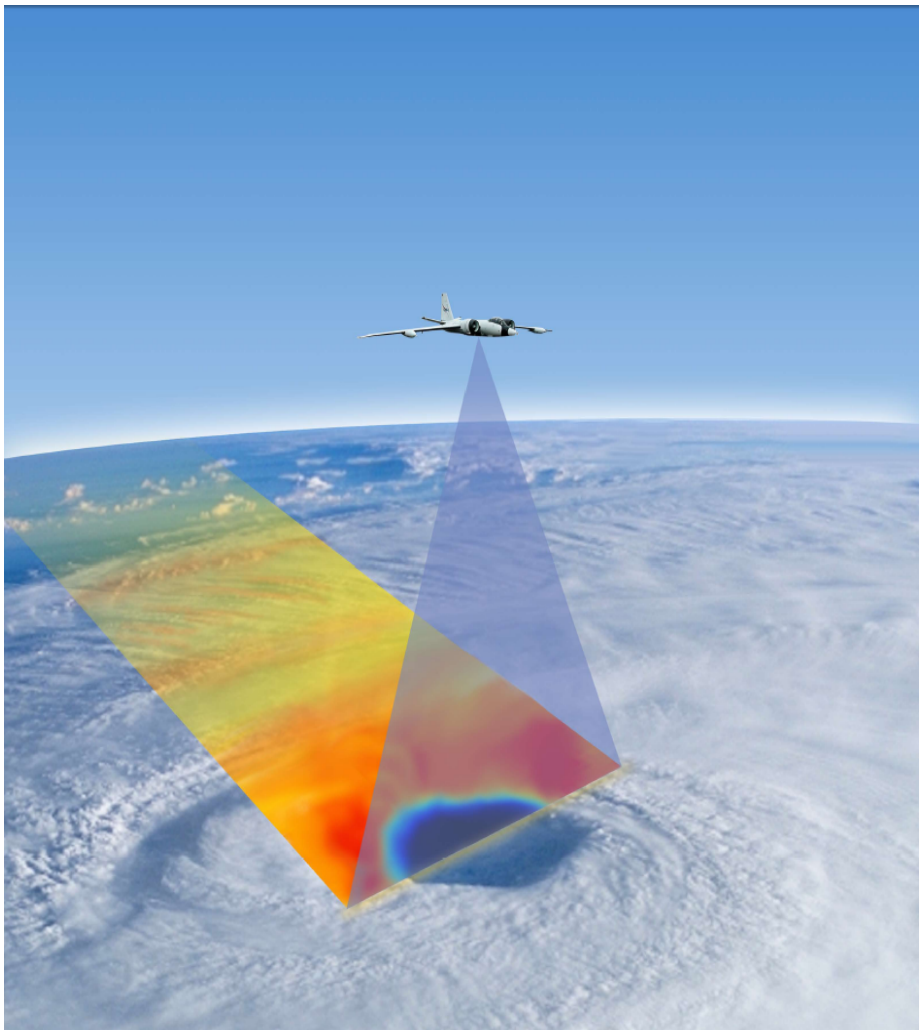
- HIRAD team
- Reminder of HIRAD capabilities
- GRIP flights summary
- Status of data analysis
- Status of instrument upgrades
- HIRAD requirements for calibration operations
- HIRAD data products
- Real-time data capability plans

HIRAD Team

- **Dr. Timothy Miller**, *NASA/MSFC, P.I.*
  - *Atmospheric modeling, project management*
- **Mark James**, *NASA/MSFC, Lead engineer*
- **Dr. Linwood Jones**, *U. Central Fla., Co-I*
- **Dr. Chris Ruf**, *U. Mich., Co-I and lead instrument scientist*
- **Dr. Eric Uhlhorn**, *NOAA/AOML/HRD, Co-I*
- **Dr. J. Brent Roberts**, *NASA/MSFC, Co-I and data processing lead*
- **Dr. Sayak Biswas**, *NASA Post-Doc, MSFC*
- **Dr. Peter Black**, *SAIC/NRL Monterey, consultant*
- **Robbie Hood**, *NOAA sponsor and original P.I.*

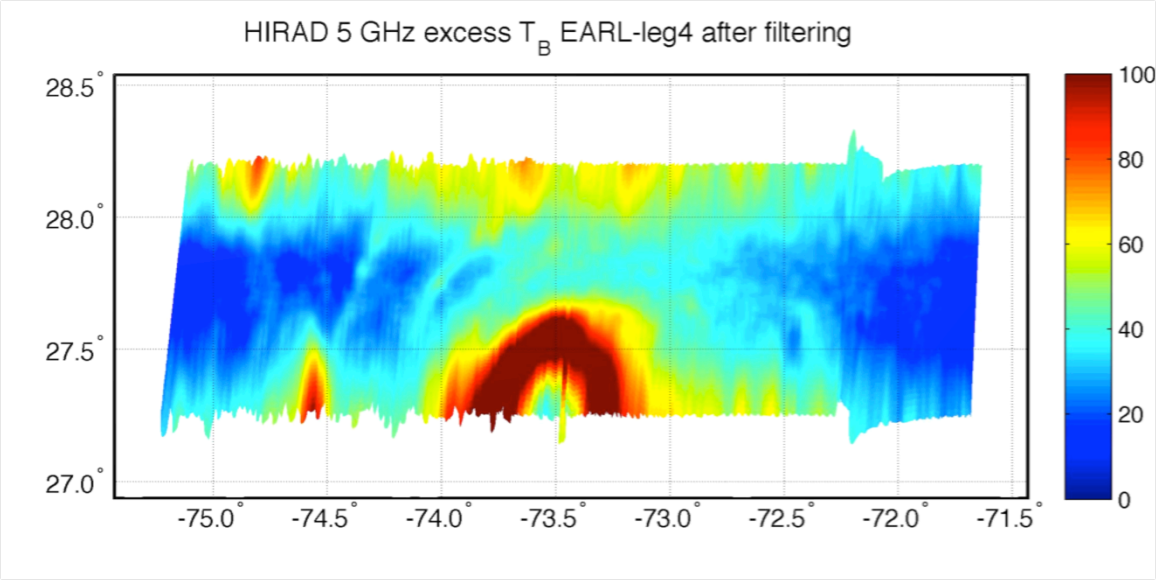
Hurricane Imaging Radiometer (HIRAD)

- A passive microwave radiometer (C-band, 4 frequencies), similar to SFMR: Measures emissivity and retrieves hurricane surface wind speeds and rain rates over a wide-swath:
  - Swath Width ~ 80 km
  - Resolution ~ 1- 5 km
  - Wind speed ~10 – 85 m/s
  - Rain rate ~ 5 – 100 mm/hr
- Key Feature: Near-instantaneous mapping of entire inner-core hurricane surface wind field and rain structure.
- Operational advantages: Surface wind and rain swath will complement SFMR and airborne Doppler radar mapping of inner-core structure for improved short-term advisories and numerical model simulations.



HIRAD Heritage

- Currently, NOAA/AOC and the 53rd WRS use the SFMR instrument on their WP-3D and WC-130J hurricane reconnaissance aircraft to measure ocean surface wind speed. HIRAD uses the same physical principles as SFMR.
- Both of these instruments use multiple C-band frequencies to retrieve surface wind speed and rain rate simultaneously.
- HIRAD's new contribution is that it obtains a swath of measurements, as shown below, rather than a single line under the aircraft.



HIRAD flights during GRIP

- Platform: WB-57, based in Houston
- Flights:
  - Late 1 Sept (Earl), deployed from Tampa
    - Major objective: Coincident measurements with P-3 (SFMR)
  - 14 Sept (Karl) – Just after Karl named, prior to crossing Yucatan
  - 16 Sept (Karl) – Best Karl flight
  - 17 Sept (Karl) – Just after landfall

GRIP Data Analysis and Preparations for HS3

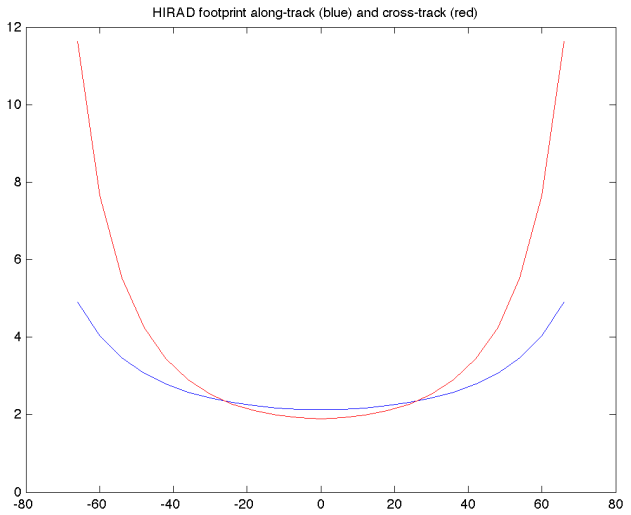
- Rain rate and wind speed retrievals require at least two calibrated frequencies
  - 5 GHz T_Bs (microwave brightness temps) have been successfully produced
  - Calibration of other 3 channels is work in progress; further instrument tests are underway to enable calibration and data production
  - Geophysical model function (GMF) developed by UCF (Jones) and HRD (Uhlhorn) will be used to retrieve rain and wind, after T_B calibration is complete
- HIRAD calibration issues and mitigation for HS3
  - Calibration uses internal reference blackbody targets and noise diodes
  - Dependence of calibration algorithm on reference T_B has uncorrected instrument temperature dependence (~25^o C variation during GRIP flights)
  - Temperature correction algorithm being developed for GRIP (requires additional instrument characterization testing)
  - Thermal control subsystem being upgraded for HS3 to greatly reduce instrument temperature fluctuations
  - More temperature measurements are being added to the instrument
  - Chamber tests will be conducted this summer in preparation for HS3

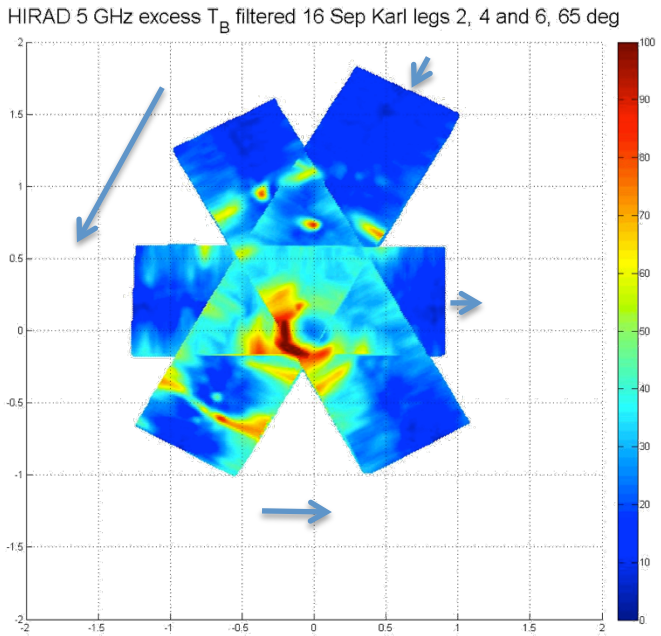
HIRAD Calibration During HS3

- In order to enable HIRAD calibration, we have some requirements and desires:
- Required
  - Before and after each flight, measurement of blackbody target to be inserted under the aircraft
  - At least two CCL calibration flight segment during each storm flight – one on transit to the storm, one on return
    - **C**lear sky conditions (light clouds okay, but no precip)
    - **C**alm sea conditions (light winds okay, prefer buoy overpass if possible)
    - **L**evel flight line (nominal aircraft pitch, no roll, straight flight line)
    - Open ocean scene (no land visible to either horizon in cross track direction)
    - > 10 sec required, >30 sec desired
- Desired
  - CCL flight segment during tests from Dryden
  - CCL flight segment as frequently as possible during storm flights (*e.g*. beginning and end of flights, between legs over the storm)

HIRAD data products

- Brightness temperatures (T_B)
  - 4, 5, 6, 6.6 GHz
  - Footprint sizes, function of nadir angle, shown on the right
- "Excess" T_B
  - Difference from modeled cross-track profile
  - Example on the right
- Storm center (at crossing times)
- Wind speed, rain rate





HIRAD real-time data processing

- This capability is under development
- We are presuming a real-time downlink capability of 1.6 Mbps, based on preliminary email discussions with Scott
- Approach will be to downlink a thinned subset of raw instrument data, and then process T_B and geophysical retrievals on the ground
- Hence, our product will be NEAR-real-time, not real-time
  - Swath image production ~15-30 min after flight leg
  - Will require GH nav data for lat-lon placement